

Issued September 20, 1913.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY
SURVEY, E. A. BIRGE, DIRECTOR; COLLEGE OF AGRICULTURE,
UNIVERSITY OF WISCONSIN, H. L. RUSSELL, DEAN;
A. R. WHITSON, IN CHARGE SOIL SURVEY.

SOIL SURVEY OF KEWAUNEE COUNTY,
WISCONSIN.

BY

W. J. GEIB AND A. H. MEYER, OF THE U. S. DEPARTMENT OF
AGRICULTURE, AND E. J. GRAUL, OF THE WISCONSIN
GEOLOGICAL AND NATURAL HISTORY SURVEY.

J. E. LAPHAM, INSPECTOR IN CHARGE NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1911.]



WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., February 12, 1913.

SIR: I have the honor to transmit herewith the manuscript report and map covering the survey of Kewaunee County, Wis., and to request that they be published as advance sheets of the field operations of the Bureau of Soils, 1911, as authorized by law.

The selection of this area was made after conference with the State officials cooperating with the bureau in the work of surveying and classifying the soils of Wisconsin.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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MAP.

Soil map, Kewaunee County sheet, Wisconsin.

SOIL SURVEY OF KEWAUNEE COUNTY, WISCONSIN.

By W. J. GEIB and A. H. MEYER, of the U. S. Department of Agriculture, and
E. J. GRAUL, of the Wisconsin Geological and Natural History Survey.

DESCRIPTION OF THE AREA.

Kewaunee County is located in the eastern part of Wisconsin. It is bounded on the north by Door County, on the east by Lake Michigan, on the south by Manitowoc County, and on the west by

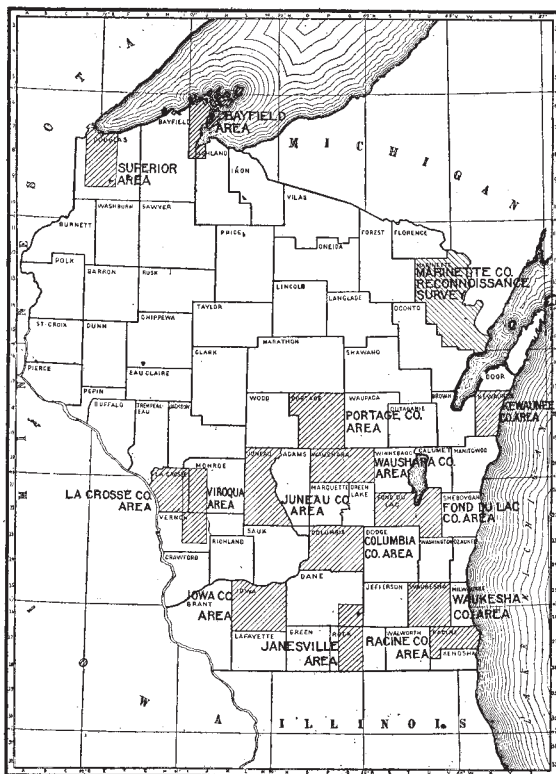


FIG. 1.—Sketch map showing areas surveyed in Wisconsin.

Brown County. The northwestern corner of the county is bounded by Green Bay for a distance of about 3 miles. The county is 24 miles long from north to south, and its greatest width is about 18 miles. It comprises an area of approximately 341 square miles, or 218,240 acres.

The most pronounced topographic feature of the county consists of what is known as the Kettle Moraine, the main portion of which begins near the center of Casco Township and extends south, gradu-

ally becoming wider until it covers nearly half of West Kewaunee, half of Montpelier, half of Carlton, and the greater part of Franklin Townships. This region represents the medial moraine formed between the Green Bay and Lake Michigan glaciers. Its surface varies from level to rolling and hilly, the level tracts being much more limited in extent than the rougher areas. The topography of this section is truly glacial in character, and potholes, small swampy areas, and stony and gravelly regions are common. Several other portions of the county also have a glacial topography, although these are of much smaller extent than the one described above. The western part of Lincoln Township and the eastern part of Red River Township exhibit glacial action, and the surface is rolling over most of this section. Stones and bowlders are very plentiful over a part of the region. Another morainic belt is found to the southwest from Algoma, where the surface is quite hilly and kettle holes and small marshes are numerous. The remainder of the county is undulating to gently rolling. Some nearly level areas are found in Carlton, West Kewaunee, Luxemburg, and Red River Townships and in a few other sections. The streams throughout the county have cut deep channels through the soil-forming material, and along the Kewaunee River and some of the smaller streams numerous ravines are found branching off from the main stream valley. The height from the stream bed to the level of the surrounding country ranges from 10 to nearly 100 feet. There are also a number of ravines running back from the shore of Lake Michigan. The bluffs along the Lake range in elevation from 50 to about 100 feet above the level of the Lake, and the county as a whole probably averages from 100 to 150 feet above the Lake level.

The Kewaunee River, with its several tributaries, forms the chief drainage course of the county. It heads in the eastern part of Brown County and traverses the area surveyed, passing through Luxemburg, Casco, and West Kewaunee Townships and flowing into Lake Michigan at the city of Kewaunee. The Ahnapee River crosses the northeastern corner of the county, drains most of Ahnapee and Lincoln Townships, and flows into Lake Michigan at Algoma. A number of small streams a mile or so in length empty into the Lake. The drainage of the southern part of the county is chiefly through East Twin River and Black Creek southward through Manitowoc County into the Lake. A very small part of the northwestern corner of the county drains into Green Bay.

The first settlement in the county was made at Kewaunee in 1837. The county was organized in 1856, after which the population increased quite rapidly. Some of the first settlers came from Manitowoc County and some from neighboring States, though a large proportion came directly from foreign countries. Lincoln and Red

River Townships were first settled chiefly by Belgians, Luxemburg by Germans, West Kewaunee by Poles, and Carlton by Norwegians. Other nationalities are represented in the area, but not to so great an extent as those mentioned. All of the settlements grew, and at present all portions of the county are well populated.

Kewaunee, the county seat, has a population of 2,100 and is an enterprising city. It has a canning factory, planing mill, furniture factory, an aluminum factory, an electric-light plant, two breweries, a creamery, and a number of other industries, besides being the shipping point and distributing center for a large section. Algoma, a city of 2,250 inhabitants, is situated on the lake in the northern part of the county. It has canning, furniture, sash and door, lace, and fly-net factories, a planing mill, foundry, creamery, and other industries. There is a good farming country tributary to this point, and to the north the fruit industry is beginning to develop. Luxemburg and Casco are smaller towns, located on the railroad and surrounded by good farming country. Rio Creek and Clyde are also railroad shipping points. A large number of small villages are scattered throughout the county.

The Kewaunee, Green Bay & Western Railroad, which crosses the State from west to east from Winona, Minn., passing through Independence, Waterbury, Grand Rapids, Green Bay, and other points, traverses the area surveyed, touching Luxemburg, Casco Junction, and Clyde, and terminates at Kewaunee. Two freight ferries cross Lake Michigan from Kewaunee, connecting with the Ann Arbor Railroad at Frankfort, Mich., and with the Pere Marquette at Ludington, Mich. From Casco Junction a branch, called the Ahnapee & Western Railway, runs through Algoma and on to Sturgeon Bay in Door County. The main lines of steamers plying the lakes make regular stops at Kewaunee and Algoma and give this region direct water connection with Chicago, about 200 miles by water from Kewaunee, and with Milwaukee and other lake ports.

The cities and towns within the county furnish a market for considerable farm produce. Kewaunee, Algoma, and Luxemburg, with the other railroad points, provide shipping facilities for all produce sent to more distant markets. Green Bay is but 37 miles from Kewaunee by rail, from which point the Chicago & North Western and the Chicago, Milwaukee & St. Paul Railroads furnish excellent shipping facilities to the leading markets of the Middle West.

The main wagon roads of the area are graded up, and many of them are crowned with gravel and kept in good condition. Throughout the Kewaunee clay loam region the soil is heavy, and where special attention is not given to grading and keeping up the highways, travel over them becomes very difficult during wet seasons. Gravel beds are so numerous that this material can be readily obtained for road building in nearly all parts of the county. Where

gravel is not available, limestone could often be secured and crushed if the proper machinery were at hand.

Rural free delivery routes reach practically all parts of the county, and telephones have been installed in many homes. The telephone, however, is not in as common use in the country districts of this county as in those in many other parts of Wisconsin.

CLIMATE.

No long-established records for Kewaunee County are available to show the differences in temperature and precipitation between the country along the Lake shore and the region from 2 or 3 to 15 miles inland. The records of the stations at Manitowoc and Green Bay, Wis., however, have been tabulated. Manitowoc is situated on the shore of Lake Michigan, only 16 miles south of the southern boundary of the area surveyed. The elevation of the station is 616 feet above sea level, or about 38 feet above the level of the lake. The station at Manitowoc is considerably lower than the general elevation of the upland country along the Lake shore. For example, six elevations taken in West Kewaunee Township and reported by Chamberlin show the upland country to range from 124 to 145 feet above the lake. The valley of the Kewaunee River includes practically all of the land in the county whose elevation is less than 50 feet above the lake, and this land covers an extremely small area. It is not definitely known what difference in the climatic conditions this range in elevation would show. Green Bay is 617 feet above sea level, or about 39 feet above the level of Lake Michigan. This station is also lower by perhaps 100 feet than the country along the western border of the county, although Green Bay City is but 13 miles west of the western boundary line of the survey.

Normal monthly, seasonal, and annual temperature and precipitation at Manitowoc.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	[°] F.	[°] F.	[°] F.	Inches.	Inches.	Inches.	Inches.
December.....	24	60	-21	1.7	1.5	5.5	7.0
January.....	18	51	-32	1.7	1.6	0.7	8.5
February.....	18	56	-29	1.5	0.5	2.3	7.7
Winter.....	20			4.9	3.6	8.5	23.2
March.....	28	70	-13	2.0	0.4	1.6	6.0
April.....	42	85	8	2.5	1.5	4.3	2.3
May.....	52	92	18	2.6	4.4	2.4	0.2
Spring.....	41			7.2	6.3	8.3	8.5

Normal monthly, seasonal, and annual temperature and precipitation at Manitowoc—Continued.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	<i>° F.</i>	<i>° F.</i>	<i>° F.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
June.....	62	97	33	3.4	1.5	5.2	0.0
July.....	67	100	38	3.7	1.8	5.4	0.0
August.....	66	99	39	3.1	3.5	4.8	0.0
Summer.....	65			10.2	6.8	15.4	0.0
September.....	59	96	26	3.0	1.2	1.6	0.0
October.....	48	84	11	2.6	0.5	5.0	0.4
November.....	34	69	-10	2.1	2.2	1.8	3.8
Fall.....	47			7.7	3.9	8.4	4.2
Year.....	43	100	-32	30.0	20.6	40.6	35.9

Normal monthly, seasonal, and annual temperature and precipitation at Green Bay.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	<i>° F.</i>	<i>° F.</i>	<i>° F.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
December.....	22	51	-21	1.8	1.8	3.8	10.7
January.....	16	51	-36	1.8	2.0	3.3	14.4
February.....	17	59	-33	1.7	0.7	3.2	13.5
Winter.....	18			5.3	4.5	10.3	38.6
March.....	28	72	-23	2.3	0.4	1.9	9.0
April.....	44	84	11	2.5	1.2	2.8	2.1
May.....	55	91	29	3.3	4.3	3.1	2.5
Spring.....	42			8.1	5.9	7.8	13.6
June.....	66	96	34	3.6	2.4	5.2	0.0
July.....	70	99	44	3.4	1.4	4.5	0.0
August.....	68	98	41	2.7	3.7	4.6	0.0
Summer.....	68			9.7	7.5	14.3	0.0
September.....	60	95	25	3.3	1.2	1.8	0.0
October.....	48	84	8	2.6	0.4	3.6	0.0
November.....	33	69	-12	2.0	1.5	1.7	7.0
Fall.....	47			7.9	3.1	7.1	7.0
Year.....	44	99	-36	31.0	21.0	39.5	59.2

Dates of first and last killing frosts.

Station.	Length of record in years.	Average date of—		Date of—	
		First killing frost in autumn.	Last killing frost in spring.	Earliest killing frost in autumn.	Latest killing frost in spring.
Manitowoc.....	47	Oct. 10	May 9	Sept. 24	May 31
Green Bay.....	23	Oct. 2	May 3	Sept. 16	May 30

From these tables it will be seen that the average annual rainfall of the region surveyed is about 30 inches, the greater part of which comes during the growing season, when most needed; and that during each of the six months from April to September there is a rainfall of not less than 2.5 inches. There are times during nearly every season, however, when crops suffer from lack of moisture. While the average rainfall at Manitowoc is 30 inches, it may vary from about 20 to 40 inches. The average snowfall at Manitowoc is 39.9 inches. The winters are long and severe and the summers are, as a rule, cool and pleasant. The mean annual temperature at Manitowoc is 43° F. and at Green Bay 44° F. The table showing frost data indicates that the region has an average growing season of 150 to 160 days. From 145 to 150 days, however, would probably be nearer the average for Kewaunee County alone.

The influence of the Lake tends to maintain a more uniform temperature than is found in regions more remote from large bodies of water. The climatic conditions over the county are favorable to the production of fruit when the proper locations and soils are selected. Immediately along the shore of the Lake the temperature is usually somewhat lower than it is several miles back, the coolness of the nights being particularly noticeable. Corn can be more readily matured several miles inland than immediately along the Lake shore.

AGRICULTURE.

Settlement was made in Kewaunee County as early as 1837, and at one time in its early history the town of Kewaunee was a rival of Chicago. The actual agricultural development of the region began about 1855-1860. During this period a large number of Bohemians, Belgians, Poles, Germans, and some Americans came into the county and began farming operations. Lumbering was an important industry for a considerable period, but the settler followed the lumberjack quite closely and the time which elapsed between the cutting of the timber and the clearing of the land was not nearly so great as in many other parts of the State.

The early methods of farming were crude. Cultivation was not thorough and the question of crop rotation received but little consideration. The leading type of farming consisted of the production of grain, and wheat was the principal crop until a comparatively recent date. Some oats, barley, and a little corn for fodder were also grown. As has been the experience in other sections of the State, the continued cropping, together with damage from pests and other causes, gradually reduced the yields of and profits from wheat until attention was finally given more largely to other crops.

With the decline in wheat growing a more diversified system of farming was developed, and at present the type of agriculture most largely followed consists of general farming in conjunction with dairying, which industry is gradually increasing in importance. All portions of the region surveyed are well settled, and the farms are comparatively small. The general farm crops grown at the present time in order of the acreage devoted to them consist of hay, oats, barley, rye, wheat, potatoes, and corn, with a small quantity of flax and buckwheat. The figures given below are taken from the report of the Thirteenth Census and cover the crops for the year 1909. Variations in acreage occur from year to year, owing to various causes, but this data will give a fair idea of the relative importance of the crops grown.

The total area devoted to hay of all kinds was 40,974 acres, from which a yield of 68,153 tons, or an average of about 1.5 tons per acre, was secured. Of this hay a little over half consisted of clover and timothy mixed, about one-fourth was timothy alone, and about one-twentieth clover. Very little alfalfa is grown and only 30 acres were reported, with an average yield of slightly over 2 tons per acre. Marsh hay is cut from a few of the low, wet tracts, but the quantity is not large. Such crops as peas and oats are not utilized to any extent for hay. The greater proportion of the hay is fed to stock on the farms where it is grown, although some farmers make a practice of selling a part of the crop each year.

Oats is the most extensively grown grain crop in Kewaunee County, and the yield in 1909 from 20,142 acres was 613,246 bushels, or about 34 bushels per acre. This crop seems to be fairly well adapted to the soil and climatic conditions, and practically every farmer in the area grows some oats every year. The question of the selection of good seed is receiving more attention than formerly, and as a result the quality and yield may be expected to increase. Most of the crop is fed on the farm, but a number of farmers sell some of the grain each year.

The yield of barley from 10,106 acres was 261,131 bushels, or about 25 bushels per acre. This may be considered as the leading money

crop of the county, though a small quantity is fed to stock on some of the farms.

Rye is quite an important crop in the county, and in acreage is second to barley. From 8,759 acres a yield of 134,178 bushels, or about 15 bushels per acre, was secured. This crop is grown more extensively on the sandy and loamy soils than on the clay loam.

Although the acreage devoted to wheat has been gradually decreasing for about 20 years, this crop is still being grown on quite a number of farms, and in 1909 the yield amounted to over 80,000 bushels. The acreage of winter wheat was 1,686 and of spring wheat 3,546. The yield of spring wheat was 14 bushels and of winter wheat 16 bushels per acre.

From the standpoint of acreage the potato crop is next to that of wheat, and during 1909 the yield from 1,357 acres was 85,692 bushels, or an average of about 63 bushels per acre. Potatoes are grown in all parts of the area and on nearly all of the soils. The sandy loam and loam types are better adapted to the crop than the heavy clay loam. They are grown chiefly for home use, and the industry has not developed to any extent on a commercial scale.

The acreage devoted to corn is smaller than that devoted to any of the other general farm crops. Only 781 acres were reported for 1909 and the yield was 22,438 bushels, or an average of about 28 bushels per acre. The great difficulty in the production of corn is the short season and the cool nights. One factor which often delays planting in the spring is the poorly drained condition of the fields. The ground being wet and cold, the seeds germinate slowly if at all. By tile drainage the temperature of the soil could be increased considerably and cultivation and planting begun earlier than on the undrained, cold land, thus insuring success where failure would otherwise probably result. During the past few years considerable attention has been given to the breeding of varieties of corn which would be able to withstand the most severe climatic conditions in the State. A number of farmers in the county are growing these pure-bred varieties with considerable success under the direction of the Wisconsin Experiment Station.

In addition to the crops above mentioned, there is a small acreage devoted to buckwheat and flax. These crops, however, are of minor importance. Flax is "hard on the land" and is confined chiefly to a few low, poorly drained areas bordering marshes. It is not probable that the acreage of either crop will be extended.

Among the special crops grown in Kewaunee County peas is the most important. This industry was more extensive several years ago than at the present time. While canning factories are located at Algoma and Kewaunee, the output has been reduced and some factories have gone out of business. Formerly the factory owners

rented the land from the farmers and handled the crop, but in recent years the farmers have done all of the work, selling the peas to the factories for $1\frac{1}{2}$ to $2\frac{1}{2}$ cents per pound. A portion of the crop is allowed to mature. A factory at Kewaunee buys the ripe peas and shells, splits, and cans them dry. They are sold chiefly to the U. S. Navy. In general it may be said that the yields are smaller now than formerly. The poorly drained condition of the land in many cases causes crop failure.

The production of sugar beets has not developed to a very great extent. More beets are grown on the Kewaunee loam than on other types. Yields range from 10 to 14 tons per acre and \$6 per ton is the usual price secured. The farmers pay the factory \$20 per acre for cleaning the beets.

The trucking industry has not been developed on a commercial scale in this area. Around the towns a small quantity of truck is grown to supply the local markets, and home gardens are made on all of the farms of the region, but aside from these no effort is made to develop trucking. The growing of truck crops, strawberries, etc., could well be carried on to a greater extent on the lighter soils of the area, especially where these soils are convenient to shipping points.

On a large number of the farms small apple orchards are found and the fruit appears to do fairly well, although the industry has not been developed on a commercial basis. Kewaunee County lies within the portion of the State considered to be adapted to the growing of fruit, especially apples and cherries, and some orchards are now being put out in the country north of Algoma. There are numerous good orchard sites in the area, climatic conditions are favorable, and suitable soils can be selected. It would seem, therefore, that the industry could be profitably extended if proper care is exercised in selecting varieties, planting, cultivating, etc.¹

Dairying is the most important industry followed in Kewaunee County. The product is sold chiefly in the form of cheese and butter, and cheese factories and creameries are to be found in all parts of the county. In 1905 there were but 5 creameries in the county, while in 1910 the number had increased to 10. The output of butter for 1909 was 331,781 pounds, which was an increase of about 8 per cent over the production of 1905. The manufacturing of cheese is much more extensively developed. In 1905 there were 61 cheese factories in the county. In 1910 there were 63 factories, which produced 3,991,803 pounds of cheese, an increase of about 32 per cent over the output for 1905. In 1910 there were 17,288 dairy cows in Kewaunee County, or about 54 milch cows per 100 head of cattle. By far the

¹ See Bul. 201, University of Wisconsin Agricultural Experiment Station, on "Planting the Commercial Orchard," by J. G. Moore.

greater part of the dairy stock is of mixed breeding and many of the animals would be classed as scrub stock. The type is gradually being improved, chiefly by the use of pure-bred Holstein and Guernsey sires, but this should be carried on to a greater extent than at present. There are some pure-bred cows in the county, but the number is comparatively small. While silos are used to some extent, their use is not nearly as common as it should be in a dairy country. The number of silos is gradually increasing and the dairy industry is being extended each year.

The raising of beef cattle receives but little attention in the county. But few farmers make a specialty of the beef breeds, and the stock sold for slaughtering consists chiefly of mixed breeds, which do not conform to any particular type. The horses of the area show more careful breeding than do the cattle. Heavy draft horses are common, and many farmers raise one or more colts each year and frequently have a team to sell, aside from keeping the farm supplied with good work animals. There are about 9,800 sheep in the county, but the raising of sheep is not developed to any extent in any one section. Those kept are scattered throughout the county, and no one farmer ever owns a large flock. Hog raising is carried on in conjunction with dairying. Practically all farmers raise enough pork for their own use and many have a number of hogs to sell each year. Poland China, Berkshire, Duroc Jersey, and Chester Whites were seen, though most of the hogs are of mixed breeding.

The general farm crops common to this region are grown upon nearly all of the soils in the county. The predominant soil is the Kewaunee clay loam, and many farms are made up entirely of this type. The texture of the soil can not be changed, and but little effort is made to determine whether the crops now grown are those best adapted to prevailing conditions or whether there may be other crops which could be grown more profitably. The question of the adaptation of soils to crops has received but comparatively little attention in the region covered by the present survey.

The question of crop rotation is also one which has not been carefully studied by many of the farmers, and about the same rotations are followed on nearly all of the soils, regardless of how well these may be suited to prevailing conditions. The rotation most commonly used consists of corn or peas one year, followed by one or two years of small grain, consisting of oats, barley, wheat, or rye. Clover and timothy mixed are seeded with the grain and hay is cut for one or two years. The field may be pastured for a year before plowing for corn or peas.

In many cases the methods of cultivation followed are not those best suited to the needs of the soil. This is especially true of the Kewaunee clay loam. Poor drainage conditions keep the soil wet

until late in the spring, and it often happens that the fields are cultivated before the soil is dry enough to work up properly. A puddled condition sometimes results, and considerable time and labor are required before the field is again in good tilth. Fall plowing, especially on the heavier soils, is quite common, and it is a good practice to follow, since the freezing and thawing breaks up the lumps, kills many weed seeds, and makes the soil more retentive of moisture. Stable manure is the only fertilizer in common use in the county. The plowing under of green crops is not practiced to any extent, nor are commercial fertilizers used.

While there are a number of troublesome weeds in Kewaunee County, there are two which are particularly noxious—quack grass and Canada thistle.¹ These weeds are extremely difficult to eradicate because of their peculiar nature and habits. Many fields are more than half overgrown with one or both of these, and crop yields are sometimes materially reduced because of their presence. A concerted effort should be made by the farmers of the county to rid themselves of these pests before more serious conditions develop.

In general, it may be said that the farm buildings and farm improvements throughout the county are good. The most marked exceptions to this occur on the more poorly drained portions of the Superior clay loam, till phase, and on the gravelly and very sandy soils. Farm machinery is sometimes allowed to remain unprotected because of lack of suitable storage room, and in some sections the repairing of buildings is delayed until a shiftless appearance develops. However, the majority of the farmsteads present a neat, thrifty appearance, which usually indicates a prosperous condition of the farmer. The problem of securing labor on the farms is not as difficult of solution in Kewaunee County as in many other sections of the State. As a rule the farms are small and the families are able to handle all of the work without being compelled to hire help. It is very common to see women and children working in the fields. Where the farms are larger and additional labor is necessary the wages range from \$25 to \$30 per month, and in a few cases even more. Where extra help is needed during haying and harvest time from \$1.25 to \$1.75 per day is paid.

In Kewaunee County there are 2,011 farms and the total area included constitutes 97 per cent of the area surveyed. The average size of farms is 101 acres and on the average farm 69 acres are improved. Approximately 95 per cent of the farms in the county are worked by the owners. Where renting is practiced the cash system is more common than the share system. In 1910 about 60 per cent of

¹ For a thorough discussion of this subject see "Circular of Information No. 19," on "The Control of Quack Grass and Canada Thistles," issued by the Agr. Expt. Sta., Coll. of Agr., Madison, Wis.

the farms in the county were free from mortgage debt. The average value of all farms in the county in 1900 was \$22.64 per acre. In 1910 the average value had risen to \$52.20 per acre. Farm values vary greatly with the character of the soil and the improvements, ranging from as low as \$8 to \$10 an acre on the poorest soils to \$100 to \$125 an acre, and even more where highly improved, on the best soils.

One of the greatest needs of the county as a whole is drainage. The Superior clay loam, till phase, in particular requires tile drains. Parts of the Kewaunee clay loam would also be improved by tiling. The land is cold and wet in the spring and planting is often delayed. Over portions of many fields, especially where the surface is undulating or level, crops are a total failure because of the excess of moisture. The installation of tile drains would be a good investment and the owners of such land should not delay making such improvements. If only three-fourths of a field is producing good yields the loss of the one-fourth may mean the difference between financial success and failure for the year. On high-priced land it is poor economy to allow any portion of the farm to be unproductive of maximum crops.

The growing of green manuring crops to be plowed under could well be practiced to a greater extent for the purpose of supplementing the stable manure. If clover were to be seeded without a nurse crop on well-drained land there would probably be less difficulty in securing a good stand. Clover is better for a green manuring crop than any of the other crops now grown in the county.

The questions of crop adaptation and rotation should receive careful study. These matters have been treated more extensively under the description of the various soil types.

SOILS.

The soils of Kewaunee County have been derived from ice-laid, lake-laid, and stream-laid material. The upland soils are, with two important exceptions, derived from ice-laid material. From it the three most important soils of the county are derived. They are included and mapped as members of the Kewaunee, Superior, and Miami series.

The Kewaunee and Superior soils are alike in all respects except that of drainage. The Kewaunee soils are well drained and the Superior soils poorly drained. The difference in this respect is due wholly to topography. The former occur in areas of rolling country, the latter in areas of smooth or flat country. The material of both series consists mainly of a pinkish red clay with more or less admix-

ture of sand, silt, and stones. The surface soil may be grayish or brownish in both series, but the red color of the material is always prominent in the subsoil. Both these series of soils are derived from well-defined ice-laid material in this county, yet they are known to occur in other parts of the country where they are derived from equally well-defined lake-laid material. The characteristics of the topography, however, always distinguish them. It is generally believed that the red clay constituent in both these soils was once laid down in a lake and afterwards picked up by the ice, moved to its present position, and mixed with varying amounts of stone, sand, and silt. This material seems to have been carried in the lower part of the ice sheet only. The material carried in the upper part was not red. This was deposited as a morainal ridge lying north and south along the central axis of the county, narrow at the northern end, but widening southward. This material is usually stony and sandy and is gray to brown in color. From it are derived the soils of the Miami series, the third of the three important series of ice-laid soils in the county.

The Fox series consists of the light-colored glacial material which has been modified or transported by the action of water and deposited as overwash plains or as valley fill. Four types of this series—the Fox silt loam, sandy loam, gravelly sandy loam, and sand—were mapped.

The light-colored glacial material which was deposited by water beneath the ice sheet and which is now found as morainic material, kames, and eskers, has a lower agricultural value than typical glacial till soils, since it is droughty, has a rolling surface, and a low content of organic matter. Such material has been included in the Rodman series and five distinct types were mapped—the Rodman gravelly loam, gravelly sandy loam, sandy loam, fine sand, and gravel.

The Poygan series is of very limited extent. It represents lacustrine material, the position of which has favored the growth and decay of vegetable matter to such an extent that the large amount of organic matter present imparts a black color to the soil. The subsoil is similar to the subsoil of the Superior soils. Two types belonging to the Poygan series were mapped, the Poygan silt loam and sand.

The Clyde series represents old lake beds and low, swampy tracts in which there is an accumulation of vegetable matter, but not in sufficient quantities to form Peat or Muck. The soils are black and very high in the content of organic matter. The Clyde silt loam is the only type recognized as belonging to this series.

The Genesee series includes light-colored alluvial soils in the glacial and lacustrine region and is represented in this area by two types, the Genesee loam and fine sandy loam.

The Dunkirk series represents old terraces bordering glacial lakes and is developed only to a very limited extent in the present survey. Only one type, the Dunkirk sand, was mapped.

The large accumulations of vegetable matter in varying stages of decomposition have been classed as Peat.

Such conditions as rock outcrop, gravelly or stony areas, steep slopes, and swampy areas in the various soil types have been indicated on the soil map by appropriate symbols.

The name and extent of each soil mapped in the county is given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Kewaunee clay loam.....	95,488	43.7	Kewaunee fine sandy loam....	2,112	1.0
Kewaunee loam.....	30,912	14.2	Fox sandy loam.....	2,048	.9
Miami loam.....	24,128	11.1	Rodman gravelly sandy loam..	1,792	.8
Peat.....	19,328	8.8	Genesee fine sandy loam.....	1,664	.8
Clyde silt loam.....	9,920	4.5	Rodman gravel.....	1,088	.5
Superior clay loam, till phase..	7,616	3.5	Rodman fine sand.....	1,024	.5
Fox silt loam.....	6,208	2.8	Dunkirk sand.....	960	.4
Fox gravelly sandy loam.....	3,328	1.5	Poygan silt loam.....	384	.2
Rodman sandy loam.....	3,072	1.4	Poygan sand.....	64	.1
Genesee loam.....	2,432	1.1	Total.....	218,240
Fox sand.....	2,368	1.1			
Rodman gravelly loam.....	2,304	1.1			

KEWAUNEE CLAY LOAM.

The surface soil of the Kewaunee clay loam consists of a grayish-brown clay loam, averaging 8 inches in depth, which contains a large amount of silt and only a comparatively small amount of organic matter. On drying out the surface material has an ashen-gray appearance and slight mottlings of reddish-brown are common. Gravel stones less than one-half inch in diameter are frequently found throughout the soil and subsoil, usually in small amounts, although the quantity is variable. Most of the gravel is limestone, but granite, quartz, and other rocks foreign to the region are also represented. The subsoil consists of a heavy, compact red clay loam or clay which extends to a depth of over 3 feet. The material is stiff and tenacious where typically developed, but contains small angular fragments of limestone, which are frequently so thoroughly disintegrated that they can be easily crushed. This finely broken rock, when plentiful, imparts a gritty feel and gives the subsoil a looser structure. Over a portion of the type a few bowlders occur on the surface. The type as a whole, however, is comparatively free from bowlders.

The Kewaunee clay loam in Kewaunee County differs somewhat from the type as found along the shore of Lake Superior, chiefly in containing more gravel, being less uniform throughout its occurrence, and, as a whole, a little lighter in texture. The variations are due largely to glacial action, which influenced this type to a greater extent here than in other parts of Wisconsin. While some of the variations are quite distinct, none of them are of sufficient extent or importance to be mapped separately.

The depth and color of the surface soil are variable. Where the surface is bumpy the soil is deeper and darker in the depressions than typical, while on the bumps or knolls the heavy red-clay subsoil is frequently exposed. In the western part of the county the depth to rock averages about 15 feet, which is less than in the eastern portion, and outcrops are frequently seen. In Montpelier and Franklin Townships and in a number of other places, where this type borders the morainic region, the type is itself somewhat morainic and the soil frequently contains small accumulations of sand and gravel. This material may occur as beds beneath the red clay subsoil within reach of the auger or the sand may be found at the surface—sometimes overlying the red clay. The region extending for several miles southwest from Algoma is quite morainic, containing a number of pot holes and small marshes and carrying considerable gravel in the subsoil. For a distance of 1 to 1½ miles immediately along the shore of Lake Superior the type is usually lighter in texture than is the case farther back, and pockets and small areas of sand are frequently found.

The Kewaunee clay loam is the most extensive and important type in Kewaunee County and occupies approximately half of the area surveyed. It occurs as a belt along Lake Michigan, extending from the southern boundary of the county northward to near Algoma, where it grades into the Kewaunee loam. The type is also extensively developed in the western and northwestern parts of the county covering the greater part of Red River, most of Luxemburg, nearly half of Montpelier, and a small part of Franklin Townships.

The surface of the type varies from undulating to rough and broken. The roughest sections are found along the Kewaunee River and its tributaries, where erosion has been more active than elsewhere. For one-fourth to three-fourths of a mile on both sides of the streams bordering the narrow bottom land the surface has frequently been deeply cut by ravines and rendered unfit for cultivated crops. Along the shore of the lake there are also numerous ravines. The total area of such land, however, is comparatively small. To the southeast of Rankin the type has a morainic character and is quite rough and broken, as is also the case, though to a lesser extent, in places where

it borders the Kettle Moraine. The greater part of the type is level to gently rolling. In Carlton and West Kewaunee Townships are tracts of similar soil of considerable size where the surface is nearly level, but on account of their poorly drained condition they have been classified with the Superior clay loam, till phase, which differs from the Kewaunee in topography and drainage and resulting variation in agriculture value.

The Kewaunee clay loam is of glacial origin. In order to account for the existence of such a large amount of clay of such uniform character it is necessary to postulate the existence of a body of quiet water in which it accumulated prior to the time when it was picked up by the moving ice. The ice mixed it with gravel, consisting of quartz, granite, and other rocks, and some boulders. The underlying limestone was ground up to a considerable extent by the glacier, and small fragments of this rock and limestone gravel are now found scattered through the soil and subsoil. The surface of the soil has been thoroughly leached and most of the carbonate of lime removed, leaving the soil in many places in a slightly acid condition. The subsoil, however, is quite calcareous, the amount of calcareous matter usually increasing with depth, being especially noticeable in the section between 1 and 3 feet below the surface.

The original timber growth on this type was varied and consisted of both pine and hardwoods. White pine was the most plentiful, though a small amount of Norway pine was also present. Of the hardwoods, maple, beech, birch, basswood, and some oak, hickory, and ash were found. Hemlock, cedar, and balsam also grew in this region. Over some portions of the type pine was the only growth; in other sections the hardwoods alone were found; while again the hardwoods, pines, and hemlock formed a mixed growth. All of the merchantable timber has been removed from this soil, and where not cultivated a second growth of birch, poplar, and in places some willows are found.

By far the greater part of the Kewaunee clay loam is under cultivation, and while it is a strong soil it is not as highly improved as might be expected of a region which has been settled as long as this. The chief general farm crops grown are oats, barley, wheat, rye, corn, clover, and timothy. The yields obtained are variable, owing to the heavy retentive subsoil, which keeps the land wet until late in the spring, to the methods of cultivation, which are not always sufficiently thorough, to climatic conditions, and also to the use of grain which is often not the best obtainable for seed. Corn is not extensively grown, as the season is short, though some of the new improved varieties mature in this section and fair yields are secured. Where the silo is in use the corn is fed chiefly in the form of silage. Oats yield from 20 to 40 bushels, barley from 20 to 35 bushels, wheat from 10

to 20 bushels, rye from 15 to 20 bushels, timothy about $1\frac{1}{2}$ tons, and timothy and clover mixed from $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre. Considerable difficulty is experienced in getting and keeping a stand of clover, and over portions of the type but little is grown. This type is the most difficult one in the area to cultivate and it requires heavy stock and strong tools. When plowed too wet it is apt to puddle. On the heavier phase large clods are sometimes turned up, which are quite difficult to pulverize. The poorly drained sections are more difficult to handle than where the natural drainage is good, since in the depressions and draws and even on some gentle slopes the land remains in a wet, soggy condition until quite late in the spring. The best results are obtained when the land is plowed in the fall, but this is not always possible. Stable manure is applied to the type, but green manuring is not a common practice and no commercial fertilizers are used.

Among the special crops grown on the Kewaunee clay loam the pea crop is the most important. Formerly the peas were produced chiefly for the canning factories, but many of these have shut down and now most of the crop is allowed to mature. Yields range from 10 to 20 bushels per acre. In former years considerably larger yields were secured. The soil is often too wet for this crop and failures are frequently due entirely to this one cause. Irish potatoes are grown for home use and fair yields are secured, but the industry has not been developed on a commercial scale. The type is better adapted to other crops than to potatoes.

The most important problem which confronts the farmers on this soil is that of drainage. Before the best results can be obtained on the type as a whole tile drains must be installed even on gentle slopes where the drainage seems adequate. At present the soil is cold and backward in the spring and many of the crop failures can be traced directly to poor drainage. Tile drains properly installed will mean better and larger yields, the soil will warm up earlier in the spring, crops will make a more thrifty and rapid growth, and the cultivation of the soil will become less difficult. The low, wet places which are now found on many of the farms can be drained and all parts of each field made to produce their proper share.

The selection of definite crop rotations suited to this type should be given careful attention. A four or five year rotation such as the following seems to give best results on land of this class: The first year small grains, such as oats, barley, wheat, or rye, seeded down to clover with a little timothy mixed in it. The second year clover, the first cutting being for hay and the second for seed. The third year mixed clover and timothy. The sod may be manured either before plowing in the fall, or, if the manure is fine, in the winter after the land has been plowed. The fourth year the land should be put into a cultivated crop such as corn or roots. When the field is

pastured a year after being cut for hay for two years a five-year rotation will be the result.

The organic-matter content of the type may be increased by supplementing the stable manure with green manuring crops. Legumes are better for this purpose than other plants, and clover is probably the best of the legumes. The type responds to the application of phosphorus. This element may best be supplied in the form of ground rock phosphate. The first application should be at the rate of 400 to 600 pounds per acre and this may be spread on with the manure by sprinkling it over the load on the manure spreader. Applications of about half this amount may well be made about once during each rotation.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Kewaunee clay loam:

Mechanical analyses of Kewaunee clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311611.....	Soil.....	0.8	3.0	4.6	12.2	9.0	41.5	29.2
311612.....	Subsoil.....	.5	1.6	3.3	9.1	5.7	39.3	40.4

KEWAUNEE LOAM.

The surface soil of the Kewaunee loam consists of a grayish-brown loam, with an average depth of 12 inches. It contains considerable silt, a comparatively small amount of organic matter, and some coarse material in the form of ground-up rock fragments. A small amount of gravel occurs in the soil and boulders are quite commonly found upon the surface, being very plentiful over some sections. The subsoil consists of a brownish-red clay loam, containing enough small rock fragments to impart a gritty feel to the material. Gravel is commonly found scattered through the subsoil and cobblestones and boulders are sometimes so plentiful as to make boring very difficult. The subsoil resembles that of the type mapped elsewhere as the Kewaunee clay loam, but contains much more coarse material. The gravel, rock fragments, and stones consist largely of limestone, but some granite and other rocks foreign to the region are also found. The depth to the underlying limestone rock is less than that of the Kewaunee clay loam and a number of outcrops occur.

The Kewaunee loam is an important soil in the northern half of the county. It is the predominating type in Ahnapee and Lincoln Townships, is quite extensive in Casco, and also occurs in the eastern parts of Luxemburg and Red River Townships. It is closely asso-

ciated with the Kewaunee clay loam, the boundary line between the types frequently being an arbitrary one.

The surface of the type varies from gently rolling to rolling, the roughest sections being found along the stream courses. A few undulating areas are also found, but these are of comparatively small extent. The topography is of morainic character in the northwestern corner of the county, where a morainic area starts about a mile back from the lake and a mile south of the northern county line and extends to the southwest, gradually becoming wider. The surface here is somewhat bumpy, with numerous shallow kettle holes and some small marshes. Gravel beds occur in the subsoil throughout this region.

The natural drainage of the type is good, except in depressions, draws, and in some of the small marginal areas bordering marshes, where the surface is nearly level. Along the border of the Kewaunee clay loam also the drainage is in places deficient. Tile drains could be installed to advantage over these poorly drained portions of the type. From some of the knoll tops and on some of the slopes the surface soil has been eroded and the subsoil exposed. The question of erosion, however, is not a serious one on this type, and, with only a few exceptions, the soil can be kept in place on the steepest slopes by following proper methods of cropping and cultivation.

The origin of the Kewaunee loam is the same as that of the Kewaunee clay loam. The ice sheet broke up much of the underlying Niagara limestone, which formation has contributed more largely than any other to the supply of gravel and stones mixed with the soil. Granite, quartz, and some other rocks are also found, though to a much smaller extent than the limestone. The material forming the soil contains much carbonate of lime. In some places the lime has been leached out of the surface soil to a depth of a few inches, though an acid condition does not exist over any of the type. The lime content increases with depth, the subsoil containing much more than the surface soil.

The original timber growth on the Kewaunee loam consisted chiefly of maple, beech, and hemlock, with some white pine, Norway pine, cedar, and balsam. Practically all of the merchantable timber has been removed.

The soil of this type is highly improved and by far the greater part of it is under cultivation. General farming and dairying constitute the chief lines of agriculture followed. The leading crops produced are oats, peas, barley, rye, corn, wheat, hay, and some flax. Oats are probably grown more extensively than any of the other grain crops and the yields average from 30 to 35 bushels per acre. Barley is not as important a crop as oats. Yields range from 25 to 35 bushels per acre. Corn is grown mostly for the silo, but the more

hardy varieties will mature and give fair yields. Wheat is grown to a limited extent and yields from 15 to 20 bushels per acre. Rye yields from 20 to 25 bushels per acre. Some flax is grown, especially on the low, more poorly drained areas adjoining marshes, and yields from 20 to 30 bushels per acre. This crop is considered to be hard on the land. Hay, consisting of clover and timothy or timothy alone, yields from $1\frac{1}{2}$ to 2 tons per acre. Peas constitute an important special crop on this soil and most of the product goes to the canning factories. Average gross receipts range from \$40 to \$60 per acre. In some cases as high as \$100 per acre has been received, though this is exceptional. Wet springs, with excessive hot and dry weather later in the season, sometimes cause almost complete failures. More of the crop is allowed to mature now than formerly, being sold as seed. Sugar beets are grown to a limited extent, with very fair success, and yields average from 10 to 14 tons and sometimes as high as 18 tons per acre. Potatoes are grown chiefly for home use. They are better adapted to this type than to the Kewaunee clay loam. Yields average about 125 bushels per acre.

Fall plowing is practiced quite extensively, though the type can be cultivated in the spring more readily than the clay loam. The drainage conditions are better than on the heavier types, and the soil warms up earlier in the spring and can be cultivated under a wider range of moisture conditions. Stable manure is the only fertilizer used to any extent. A green crop is sometimes plowed under, but the practice is not common. The question of crop rotations best suited to this soil receives but little attention, and quite a variety of rotations are followed, some of which are not adapted to existing conditions. One that is perhaps the most common and better than any of the others is as follows: One year corn or peas, followed by one year each of barley and oats, with the last the land seeded to clover and timothy. Hay is cut for one or two years and the field may be pastured for a year before again plowing for corn. Manure is usually applied to the sod.

A portion of the Kewaunee loam is very stony, and while many of the stones have been gathered into piles, there is still a sufficient quantity in the soil to interfere to some extent with cultivation. The crop rotation and method of fertilization suggested for the clay loam may be used successfully on this type, although the loam is easier to handle, better drained, and a somewhat earlier soil. The dairy industry could well be more extensively developed. More attention should also be given to growing corn, and it would be advisable to grow alfalfa. The sugar beet industry could be profitably extended. Methods of cultivation in general could be made more effective by more frequent tillage, to secure and maintain a mulch at the surface which would tend to conserve the moisture

during the dry part of the growing season. In the northeastern part of the county some fruit is being produced on this soil with success. This is an important industry and could well be extended since both soil and climate are favorable to its development. Cherries and apples are the fruits best suited to this region.

The price of farms of this type ranges from \$75 to \$100 or more an acre, depending upon the location and improvements.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of the Kewaunee loam:

Mechanical analyses of Kewaunee loam.

Number.	Description.	Fine gravel.	Coars ^s sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311609.....	Soil.....	2.0	4.7	8.5	20.2	13.7	41.7	8.7
311610.....	Subsoil.....	.9	3.0	6.5	20.2	11.3	34.6	22.6

KEWAUNEE FINE SANDY LOAM.

The surface soil of the Kewaunee fine sandy loam consists of a brown fine sandy loam or loamy sand, having an average depth of 8 inches. This is underlain by a yellow or brownish-yellow medium sand, extending to a depth of 2 to 3 feet, where red clay is encountered. In some of the areas gravelly material is found in the subsoil. The depth of the sandy covering over the clay is variable, and may be over 3 feet. In a number of places the clay appears at the surface, but these variations were seldom of sufficient extent to be mapped separately. Where the deep sand was developed widely enough it was classed with the Rodman fine sand, while the clay exposures were mapped as Kewaunee clay loam when of sufficient extent. The areas northeast of Algoma contain more silt and fine sand than the typical soil.

This type is of very limited extent, covering a total area of only about 3 square miles. The largest area is found about 5 miles northeast of Algoma, along the lake shore. Small patches were mapped along the shore of Green Bay, in the western part of West Kewaunee Township, in the eastern part of Carlton Township along the lake, and in a few other sections, mostly in the northern part of the county.

The topography of the type as a whole is gently rolling to rolling, although over a portion of its extent it is undulating or slightly bumpy. It is sometimes found as very low, narrow ridges only a few feet above the surrounding soils. The natural drainage of the type is good. It retains moisture well on account of the underlying clay.

The heavy clay is of the same origin as the other Kewaunee types. The sandy covering is in part glacial débris dumped by the ice sheet and in part a wind-blown deposit. Some of the ridges have the appearance of eskers, containing considerable gravel, which shows stratification in places. The sandy soil shows acidity in places and a growth of sorrel is frequently seen. The clay subsoil is not acid.

The original timber growth consisted chiefly of pine with some hardwoods, hemlock, and cedar. All of the best timber has been cut and the type cleared.

The Kewaunee fine sandy loam is considered a fairly good general farming soil and nearly all of it is under cultivation. It is easy to cultivate and responds well to fertilization, stable manure being the only fertilizer used to any extent. Average yields of 40 to 65 bushels of corn, 20 to 30 bushels of oats, 20 to 25 bushels of barley, 15 to 25 bushels of rye, and 100 to 125 bushels of potatoes per acre are obtained, these being the usual crops grown. Very little wheat and hay are produced.

The soil is low in organic matter and in order to supply this the stable manure should be supplemented by green manuring crops, for which purpose the legumes are best. Where the soil shows acidity an application of about 1,200 pounds of ground limestone per acre would be found beneficial. The type is better adapted to truck and small fruits, including strawberries, than to general farming, and should be developed along these lines. Some cherries are being put out. Apple culture would also be successful on this type of soil.

The price of land of this type ranges from \$40 to \$65 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Kewaunee fine sandy loam:

Mechanical analyses of Kewaunee fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311627.....	Soil.....	0.4	5.0	17.7	38.4	13.4	14.7	10.2
311628.....	Subsoil.....	.0	6.3	23.0	40.0	13.4	10.2	6.6

SUPERIOR CLAY LOAM, TILL PHASE.

The surface soil of the Superior clay loam, till phase, to an average depth of about 8 inches, consists of a dark-gray or grayish-brown clay loam which contains a large amount of silt and only a small amount of organic matter. When dry the surface few inches, which is the most silty, frequently has an ashen appearance. Slight mottlings of reddish-brown are common. The subsoil consists of a heavy,

compact, tenacious red clay or clay loam which extends to depths greater than 3 feet. Commonly a little gravel is found on the surface and mixed with the soil and subsoil and finely broken rock fragments may also occur. Most of this material is of limestone.

The type covers an area of approximately 11 square miles and is confined to West Kewaunee and Carlton Townships. The surface is level to very gently undulating and the natural surface and under-drainage deficient. In texture and structure the type very closely resembles the Kewaunee clay loam, though it may be a little heavier. It differs from that type chiefly in topography and the resulting differences in drainage and agricultural value. It is surrounded by Kewaunee clay loam and the line separating the two types is usually an arbitrary one.

The Superior clay loam, till phase, occupies a plain slightly more than 100 feet above the level of Lake Michigan, into which the streams and ravines leading to the lakes have not as yet cut their way. In time the entire type will doubtless be dissected by erosion channels and the surface features changed to be the same as the Kewaunee clay loam. At present the surface is dotted with numerous slight depressions in which water stands in the spring and after heavy rains. The differences in elevation between the lowest portion of the depressions and the higher land intervening varies from 2 to 6 feet, with an average of about 3 feet. On an acre there may be four or five such depressions. Some have an outlet leading into the adjoining one, though quite a few have no outlet and are doubtless pot holes.

The material composing the Superior clay loam, till phase, is of lacustrine origin, but since its first deposition it has been modified by glacial action, though the evidences of such action are not nearly as plentiful on this type as on the Kewaunee clay loam. The subsoil is quite calcareous, but the surface has been leached, and but little if any lime carbonate remains in the surface soil.

The original timber growth consisted of white pine and hardwoods. In some places the growth was chiefly pine, while in others maple and beech predominated. Very nearly all the timber has been removed and the land put under cultivation. What woodlots remain have had the best timber removed.

By far the greater proportion of the type is under cultivation. While it is naturally a strong soil it is not as highly improved as might be expected in a section which has been settled as long as this. The chief crops grown are oats, barley, wheat, rye, corn, clover, and timothy. The description of the agricultural conditions, the crops grown, and the farming practice for the Kewaunee clay loam will also apply to this type, with the exception that the average yields on the Superior clay loam, till phase, are slightly lower. This is due to the fact that the type as a whole is much more poorly drained

naturally and in almost every field there are numerous small spots where the various crops are damaged or are a failure. On account of the poor drainage the soil is wet and cold in the spring and planting is frequently delayed. Cultivation is somewhat more difficult than on the Kewaunee clay loam.

The most important problem in the management of this soil is the question of drainage. A few open ditches have been dug, but tile drains are not at all common in this region. Practically all of the type could be successfully tile drained, and until this is done the best yields possible can not be obtained. With the thorough drainage of the type entire fields will be returning maximum yields and there will be no "lazy" spots to absorb the profits. More thorough cultivation will also be possible with drainage. As the type is deficient in organic matter, this should be supplied by supplementing the stable manure with green manuring crops. The type responds to the application of rock phosphate and about 500 to 600 pounds per acre could profitably be spread upon the land with the stable manure.

MIAMI LOAM.

The surface soil of the Miami loam consists of a grayish-brown medium-textured loam, with an average depth of 10 inches. The content of organic matter is comparatively low, except in depressions, where it has accumulated owing to deficient drainage. Boulders, mostly of limestone, frequently occur on the surface, and gravel is often found mixed with the soil. The subsoil consists of a yellowish to chocolate-brown clay loam of rather light texture, and contains a large amount of ground-up rock, principally limestone, which increases with depth and imparts a gritty feel. At from two to three feet this gritty material, together with gravel and cobblestones, is frequently quite plentiful, and over portions of the type gravel beds are encountered. In Franklin Township, where the type is associated with the Rodman sandy loam, large quantities of sand are mixed with the soil. This variation is most pronounced in the southern sections. North of Ellisville there is more silt in the soil than is typical, and also some fine sand. Rock outcrops occur frequently in Montpelier and Franklin Townships, though the depth to bedrock usually ranges from 6 to 10 feet or more. Where gravel beds occur beneath the soil, pockets of sand are also frequently found. The slopes and tops of knolls are sometimes eroded and the underlying subsoil exposed.

The Miami loam is confined to the southern half of the county and is the predominating type in Franklin and Montpelier Townships. It is the only soil of the Miami series in the area, and numerous small tracts of Rodman gravel, gravelly sandy loam, sandy loam,

fine sand, Clyde silt loam, some marshy areas, and also soils of the Fox series are found associated with it.

The surface of this type varies from rolling to rather hilly, although a bumpy topography is developed over a considerable area and there are tracts of small extent where the surface is only gently undulating. On account of the surface features and the underlying gritty subsoil the natural drainage is good, except in depressions, draws, etc., where a single line of tile would usually be sufficient to carry off the excess water.

The Miami loam is of glacial origin and consists of material worked over and ground up by the ice sheets of the Lake Michigan and Green Bay Glaciers and deposited in what is known as the Kettle Moraine. It contains a considerable amount of limestone ground from the underlying rock, together with some material which is foreign to this region. Gravel and boulders of limestone, granite, quartz, etc., are quite common on the surface and in both soil and subsoil. On account of the high content of finely ground limestone and limestone gravel, the mass of the material composing the type is calcareous. The carbonate of lime has been leached from the surface in places, however, and in some sections a slightly acid condition exists. Over a part of the type sweet clover is found growing along the roads, and in such places the soil is not acid.

The original timber growth consisted chiefly of maple and beech, some red and white oak, hickory, ironwood, and a scattering of white pine and hemlock, with some cedar in the low places. There are still quite a number of valuable woodlots on this type, and from 5 to 10 per cent of the land is in timber. The remaining timber is mostly beech and maple.

The Miami loam is a fairly good general farming soil, and by far the greater part of it is under cultivation and well improved. The type of agriculture followed consists chiefly of general farming and dairying. The crops grown are oats, barley, corn, hay, rye, peas, and a small amount of wheat. The yields obtained are fairly well represented by the following figures, though there is considerable variation from year to year: Oats, from 20 to 45 bushels; barley, 20 to 35 bushels; rye, 15 to 25 bushels; wheat, 10 to 15 bushels; and hay, 1 to 2 tons per acre. It is difficult to get a stand of clover, and the greater part of the hay is timothy. Comparatively little corn is grown to maturity. It is cut and preserved as silage. Some varieties of corn will mature, however, and fair yields are secured. Among the special crops peas are the most extensively grown. Yields of from 25 to 40 bushels per acre have been secured in former years, but at present the range is from 10 to 15 bushels. Potatoes are grown for home use, and yields of from 100 to 150 bushels per acre are secured.

The rotation most commonly followed consists of corn, peas, or potatoes for one year, followed by oats and barley one year each, the last crop being seeded down to clover and timothy. Hay is cut for one or two years, and the field may be pastured for one year before being plowed again for a cultivated crop. Manure is usually applied to the sod in the fall or to the plowed field during the winter. The type is easier to cultivate than the Kewaunee loam, and while the bowlders and gravel sometimes interfere to some extent with cultivation, a good seed bed can be secured with comparatively little difficulty. On the slopes and hilltops, where the surface has been eroded, the soil is heavier and more difficult to handle than elsewhere. Where the gravel is near the surface, the type is somewhat droughty, though such areas are comparatively small. Where the subsoil is heaviest and the surface undulating, crops of peas sometimes suffer from an excess of moisture during seasons of heavy rainfall.

In the cultivation of this soil an effort should be made to increase the organic-matter content by supplementing the stable manure with green manuring crops. If an acid condition exists, it may be corrected by the application of 1,200 pounds of ground limestone per acre. Alfalfa should be tried, on all dairy farms at least, and with proper management it should be successfully grown. More attention should be given to the selection of crop rotations best suited to the type and to securing a good quality of seed. More corn could well be grown, and the dairy industry should be more extensively developed.

Farms on the Miami loam range in value from \$50 to \$90 an acre, depending upon location and improvements.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Miami loam:

Mechanical analyses of Miami loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311623.....	Soil.....	2.9	6.1	8.4	19.9	11.6	43.4	7.7
311624.....	Subsoil.....	1.5	2.9	4.1	9.8	19.5	51.4	10.7

RODMAN GRAVELLY LOAM.

The surface soil of the Rodman gravelly loam consists of a brownish-gray sandy loam of medium texture, extending to an average depth of 8 inches, and containing considerable gravel. Gravel and bowlders are commonly found upon the surface, frequently in

sufficient quantities to interfere with cultivation. The subsoil consists of a reddish-brown gravelly clay loam to a depth of 12 to 14 inches, where it grades into a mass of sand and gravel. Boulders are also found mixed with the soil and subsoil and it is frequently impossible to bore to a greater depth than 18 inches. The gravel and stones consist largely of limestone, though other rocks foreign to this region, such as granite and quartz, are also found.

The Rodman gravelly loam is of small extent and occurs in small and widely scattered areas. A narrow tract about 3 miles long is found in the western part of West Kewaunee Township, a smaller area lies due south from Pilsen, in Montpelier Township, a few patches occur in the northwestern part of Franklin and the southwestern part of Carlton Townships, and several areas are scattered along the Kewaunee River northwest of Casco Junction.

The surface of the type varies from gently rolling to rolling and bumpy. In the Montpelier area some of the hills rise about 100 feet above the level of other surrounding soils. On account of the uneven surface features and the loose, open nature of the subsoil the natural drainage is good, often excessive, and the soil is droughty, except during seasons of abundant rainfall or when the rainfall is well distributed.

The Rodman gravelly loam is of glacial origin and forms a part of the Kettle Moraine. Much of the material consists of ground-up limestone from the underlying bedrock. In some places the gravel shows stratification, indicating that some of the material at least has been influenced by the action of water. Because of the high content of limestone material the soil is not in an acid condition.

The original timber growth consisted chiefly of maple, oak, beech, and hickory, with now and then some pine and hemlock. Quite a large part of the type is still in timber.

The Rodman gravelly loam is but little utilized for cultivated crops, since it is droughty and quite rough. In the areas of good land between the gravelly hills good crops could be produced, but such tracts are irregular and often inconveniently located. Where the type is cultivated the yields are low, except in a few places where the surface soil is deeper than usual. Good grazing is furnished during the spring and early summer, but during the dry part of the summer the grass often dies down.

Where the type is timbered it should be allowed to remain in forest. Where the soil is deeper than usual, from 18 to 20 inches to the gravel, fair crops can be secured, especially during years of heavy rainfall. On such tracts alfalfa might be grown successfully. As a whole the type is better adapted to grazing than to cultivated crops.

RODMAN GRAVELLY SANDY LOAM.

The surface soil of the Rodman gravelly sandy loam consists of a yellowish or grayish brown sandy loam, with an average depth of 8 inches. It contains a large quantity of gravel, and in places bowlders occur upon the surface. The structure of the material is loose and open and the amount of organic matter present is small. The knolls are very gravelly, while in the depressions the soil is quite deep and rich. The subsoil consists of a brownish, sandy gravelly loam, which grades into yellow sandy material and gravel at about 18 inches. A gravel bed occurs under most of the type below 2 or 3 feet. In a few instances traces of red clay were found in the gravel beneath this type.

The Rodman gravelly sandy loam is of very small extent and of little importance. It is found in West Kewaunee, Luxemburg, Lincoln, and Red River Townships, but the areas are small and scattered.

For the most part the surface is bumpy or gently rolling to rolling. In sections 10 and 11 Luxemburg Township, the type occurs as a ridge and is rather hilly. On account of the surface features and the gravelly nature of the soil, the natural drainage is somewhat excessive and the type is droughty.

The Rodman gravelly sandy loam is derived from the glacial material which occurs here as a part of the Kettle Moraine. The greater part of the gravel and stones in the type are of limestone material, though some granite, quartz, and other rocks foreign to the region are also present. The gravel in the subsoil shows stratification in places.

The original timber growth consisted of beech and maple, with some white pine and hemlock. All of the good timber has been removed.

Much of the type has never been put under cultivation, but where tilled the crops common to the region are grown. The yields, however, are low. The methods of cultivation and the rotations followed are similar to those on the other sandy soils of the area. The presence of the gravel and bowlders somewhat interferes with tillage, and the steep slopes also sometimes prohibit cultivation. Where not plowed the type is used for grazing and furnishes fair pasture during the spring and early summer.

The type has a low agricultural value and part of it could be considered as nonagricultural. The steeper slopes could well be reforested. On the undulating and gently rolling areas the water-holding capacity of the soil can be increased by increasing the organic matter content, though this will not overbalance the effect of the gravelly subsoil. Most of the soil is better suited to grazing than to cultivated crops.

RODMAN GRAVEL.

The surface soil of the Rodman gravel consists of a light-brown gravelly loam, about 4 inches deep, and is underlain by beds of gravel and gravelly sand. Gravel and boulders are present on the surface and are mixed with both soil and subsoil.

The type is of very small extent and of little importance. Small areas are found in Red River, Luxemburg, and Montpelier Townships and in a number of other sections of the county, but always in small patches.

The type is characterized by a bumpy topography, with numerous kettle holes and a number of long, narrow ridges. Some areas consisting of single hills of gravel are encountered. Some of the areas are gently rolling. The differences in elevation range from 10 to 50 feet or more from the depressions to the crests of the ridges and hills. The natural drainage is excessive and the type is very droughty.

The Rodman gravel is of glacial origin and represents stratified morainic material. A very large percentage of the gravel, cobblestones, and boulders consists of limestone, though some stones foreign to the region are also found. On account of the high content of limestone material the type is not acid.

The original timber growth consisted chiefly of maple and beech, with a scattering of pine and hemlock. A portion of the type is still in timber, but the best timber has been removed.

A few fields have been cultivated, but not with success. The soil furnishes pasture for the spring and early summer. It must be considered a nonagricultural soil.

No efforts should be made to cultivate this soil. Where forested it should be allowed to remain in timber. It is thought the cultivated portion of the type could be reforested with profit.

RODMAN SANDY LOAM.

The surface soil of the Rodman sandy loam consists of a yellowish-brown medium sand, with an average depth of 8 inches, and containing an appreciable amount of fine sand but only a comparatively small quantity of organic matter. In structure the material is rather loose and the amount of clay present is not large. The subsoil consists of a fine to medium sand of a yellowish color, which usually grades into a sticky sandy loam at from 30 to 36 inches. A small quantity of gravel is mixed with the surface soil, while gravelly material and occasionally a gravel bed is encountered at a depth of about 3 feet. Boulders are sometimes present on the surface. As a whole this soil is somewhat lighter in texture than the typical Rodman sandy loam as mapped in other areas.

The type is not extensive. It is found in the morainic portion of the county and is confined chiefly to Carlton, Franklin, Montpelier, West Kewaunee, and Casco Townships. The areas range in size from a few acres to about 1 square mile.

The surface varies from gently rolling to rolling, with a few small undulating areas. On account of the surface features and the loose, open character of the material, the natural drainage is excessive and the soil is droughty, although the sticky sandy loam retains moisture fairly well. Erosion is not a problem to be considered on this soil.

The Rodman sandy loam is of glacial morainic origin and some of the material at least is stratified. A large amount of the gravel and stones are of limestone, having been ground from the underlying rock by the ice sheet. Other rocks foreign to the region are also present, but in smaller quantities. The surface soil frequently shows some acidity.

The original timber growth consisted chiefly of maple and beech, with some white pine and hemlock. The type has been cleared of the virgin forests.

Most of the Rodman sandy loam is under cultivation and during normal seasons fair crops are secured. The usual crops grown and the yields secured are as follows: Oats, 20 to 30 bushels; rye, 15 to 20 bushels; wheat, grown but little, 5 to 15 bushels; peas, from 8 to 12 bushels; and hay, three-fourths of a ton to 1½ tons per acre. But little corn is grown to maturity, though some is produced for fodder. The rotation most commonly followed consists of corn or peas one year, oats one year, rye one year, or oats seeded to clover and timothy. After hay is cut for one or two years the field may be pastured, if there is no low, wet pasture land on the farm. When other pasture is afforded this soil is not grazed at all. Stable manure is the only fertilizer applied to the type and the methods of cultivation could be improved upon. No difficulty is experienced in securing a good seed bed, and only light tools are required for handling the soil.

The type is low in organic matter and the method of farming followed should include an attempt to increase the humus-forming material. Stable manure should be supplemented by plowing under green manuring crops, and for this purpose the legumes are best. Where the soil is acid, ground limestone should be applied and an effort should be made to get clover started, even though commercial fertilizers are necessary. The use of about 300 pounds of acid phosphate and about 100 pounds of the muriate or sulphate of potash at the time of seeding to clover will greatly assist in making this crop successful. A rotation consisting of a small grain crop, clover, and potatoes is well suited to this soil. A crop of clover should be plowed under occasionally.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of the Rodman sandy loam:

Mechanical analyses of Rodman sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311635.....	Soil.....	1.2	5.7	10.5	41.3	20.7	16.6	4.1
311636.....	Subsoil.....	.2	1.5	9.3	56.6	24.3	4.8	3.2

RODMAN FINE SAND.

The surface soil of the Rodman fine sand consists of a grayish-yellow, loose, incoherent medium sand, to an average depth of 6 inches and containing only a very small amount of organic matter. Where not protected by a growing crop the material sometimes drifts. In the low areas the soil is darker in color than in other places. The subsoil consists of a loose, incoherent yellow sand, usually somewhat finer in texture than the surface material. At from 5 to 10 feet gravelly clay is encountered and this usually grades into very gravelly and stony material. Small amounts of gravel are scattered through the surface soil and the subsoil in places.

The type is of very small extent, occupying only a few square miles. It is confined to the morainic section and small areas occur in western Carlton, West Kewaunee, and to a smaller extent in Montpelier and Casco Townships.

The surface of the type is gently rolling in topography. On account of the very sandy nature of the material, the natural drainage is excessive, and the type is droughty.

The soil constituting this type is derived from the glacial débris which forms the Kettle Moraine.

The original timber growth consisted chiefly of white pine, with some hemlock and a few hardwood varieties. All of the timber has been removed.

The crops common to the region are grown upon this type, but the yields are low and the dry weather frequently causes crop failures. Crop rotations have not been definitely established and the methods of cultivation followed are not especially adapted to this type of soil.

The soil is deficient in organic matter and this should be supplied in the form of stable manure, green manuring crops, or by applying peat. It is also acid, which condition may be corrected by applying ground limestone at the rate of about 1,200 pounds per acre. An effort should be made to grow clover. The use of acid phosphate and muriate of potash as suggested for the Rodman sandy loam may be

found necessary. The type in itself is better suited to the production of early truck crops than to general farming, and where located within reach of markets or shipping points it should be devoted to this type of farming.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Rodman fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311629.....	Soil.....	0.1	2.9	15.0	64.3	8.3	5.2	3.9
311630.....	Subsoil.....	.0	1.7	16.7	67.0	9.7	1.9	2.9

FOX SILT LOAM.

The surface soil of the Fox silt loam consists of a medium brown loam, having an average depth of 10 inches and containing some fine sand and a large amount of silt. The soil is fairly loose in structure, but is usually deficient in organic matter. The subsoil consists of a yellowish-brown or sometimes reddish-brown clay loam, which is usually quite gritty. At a depth of from 16 to 24 inches gravel, showing more or less stratification, is usually found. This gravel is mixed with some finely ground rock and consists chiefly of limestone material, though such rocks as granite, quartz, etc., are also represented. In places gravel is scattered over the surface of this type, and the gravel beds sometimes come within a few inches of the surface. Stones and boulders do not occur upon the surface.

The type is found chiefly in Franklin, the western parts of Carlton and West Kewaunee Townships, and in the eastern part of Montpelier Township, where it is associated with the Kettle Moraine.

The surface of the soil is level to gently undulating, and on account of the loose, open character of the subsoil and the gravel beds which occur beneath the whole type, the natural drainage is very good and in places excessive. During late summer or at times of insufficient rainfall the soil is droughty.

The Fox silt loam consists of glacial and morainic material which has been reworked to a greater or less extent by streams from beneath the ice sheet and deposited in the form of overwash plains. The surface material is sometimes slightly acid, although the subsoil contains a large amount of limestone debris.

The original timber growth consisted chiefly of maple and beech, with a scattering of pine, hemlock, and some cedar. Practically all of the timber has been removed.

Nearly all of the type is under cultivation and devoted to general farming and dairying. It is a fair soil, though it suffers from drought more than the Miami loam. The usual crops grown and average yields are as follows: Oats from 30 to 40 bushels, barley from 25 to 35 bushels, rye from 15 to 25 bushels, and clover and timothy about $1\frac{1}{2}$ tons per acre. A little wheat is still grown, yielding from 10 to 15 bushels per acre. Some corn is produced, but mostly for fodder or for the silo. A little alfalfa is also grown with fair success. Of the special crops, peas yield from 15 to 18 bushels, but this crop is quite uncertain, and potatoes from 125 to 150 bushels per acre. The rotation most often followed consists of corn or peas, oats followed by barley, and rye or wheat, with which the land is seeded to clover and timothy. Hay is usually cut for two years and the land may be pastured for a year before again being plowed for corn or peas. Manure is usually applied to the sod. The soil is comparatively easy to cultivate and a good, mellow seed bed can be readily obtained. It can be worked under quite a wide range of moisture conditions. Crops can usually be put out earlier in the spring than on the Kewaunee clay loam, the Kewaunee loam, or the Miami loam.

Since the type is deficient in organic matter, this should be supplied by supplementing the stable manure with green manuring crops. Where an acid condition exists ground limestone should be applied at the rate of about 1,200 pounds per acre. With the soil well supplied with organic matter and in a sweet condition, there should be less difficulty in securing a stand of clover. It would seem that alfalfa could be grown to a much greater extent and should be tried by a greater number of farmers, especially those engaged in dairying. Inoculation of the soil may be necessary. This may be done by sowing 500 pounds per acre of soil from an old alfalfa field. Corn should be grown to a greater extent, as some of the recently improved varieties will mature. More silos should be used. The dairy industry could be profitably extended.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of the Fox silt loam:

Mechanical analyses of Fox silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311625.....	Soil.....	0.9	4.2	5.5	10.3	19.7	53.1	5.8
311626.....	Subsoil.....	10.1	14.9	16.1	26.2	11.1	13.3	7.8

FOX SANDY LOAM.

The surface soil of the Fox sandy loam consists of a light-brown or grayish medium sandy loam, having a loose structure, and extending to an average depth of 8 inches. It contains only a small amount

of organic matter, except in depressions, where slight accumulations occur. The subsoil consists of a yellowish-brown or reddish-brown medium sand, which becomes somewhat loamy at from 12 to 18 inches. A thin layer of brownish clay loam is sometimes encountered at about 18 inches. Below this depth beds of medium to coarse sand and fine gravel showing stratification in places are found. The gravel and small rock fragments are somewhat angular and show but little indication of water action.

This type is of small extent and does not occupy more than 3 square miles. Patches are found in Franklin, West Kewaunee, Casco, and Carlton Townships.

The surface of the Fox sandy loam is flat to gently undulating, and on account of the underlying beds of sand and gravel and the loose structure of the surface soil the natural drainage is excessive and the soil is droughty.

The material composing this type consists of glacial *débris* which has been reworked by glacial streams issuing from beneath the ice sheet and redeposited in the form of overwash plains. While the subsoil is rich in limestone gravel and ground-up rock, the surface soil shows an acid condition.

The original timber growth consisted chiefly of pine and hemlock, with some beech, maple, and a few other hardwoods.

The greater part of the type is under cultivation and during normal seasons fair crops are obtained. The type is so inextensive that there are no farms and but few fields situated entirely upon it, and no special system of rotation particularly adapted to it has been worked out. In crop adaptation and size of yields the type is slightly better than the Rodman sandy loam, chiefly because the level and somewhat lower topography enables it to retain more moisture.

Since this type is in an acid condition, deficient in organic matter, and of low water-holding capacity, the method of improvement suggested for the Rodman sandy loam also applies to it. The type is adapted to truck growing, but much of it is not conveniently located with respect to markets or shipping facilities.

FOX GRAVELLY SANDY LOAM.

The surface soil of the Fox gravelly sandy loam to an average depth of 8 inches consists of a light-brown gravelly sandy loam which is made up largely of medium and coarse sand, fine gravel, and cobblestones, with just enough clay to impart a loamy character and to make the type clod slightly in places when plowed. The structure of the material is loose and open. Its organic matter content is low. Many cobblestones have been removed from the surface. The subsoil consists of a mass of sand, gravel, and cobblestones, loose and open in structure and having a low water-holding

capacity. A high percentage of the gravel and stones is limestone material, although rock fragments foreign to the region are also present. The subsoil is stratified.

The type occupies several square miles and is confined chiefly to the western part of Casco and the eastern part of Luxemburg Townships. A few small patches occur farther south in the county in the Kettle Moraine, but all of these are of minor importance.

In general the surface of the type is flat to slightly bumpy. Northeast of Casco and for a short distance to the south it is more broken. Along the Kewaunee River and the stream which flows through Casco Township well-defined terraces have been formed, the lowest of which is considerably above the stream level. While the slopes to the streams are frequently quite steep, the land above has the appearance of an overwash plain. On account of the surface features and the gravelly nature of the material, the natural drainage is excessive and the type is droughty, though not as much so as might be expected.

The material composing the Fox gravelly sandy loam consists of glacial débris which has been reworked by streams issuing from beneath the ice sheet and again deposited in the form of terraces and overwash plains. While the gravelly material making up much of the type is largely limestone, the surface soil is slightly acid.

The original timber growth consisted chiefly of maple and beech, with some basswood, ironwood, birch, and a scattering of pine and hemlock. In a few localities the pine was quite plentiful. A second growth of poplar is frequently found where the gravel extends to the surface and the type is not cultivated.

The greater part of the type is under cultivation and most of the crops common to the region are grown. The yields, however, do not average as high as on the heavier soils. Oats yield from 20 to 30 bushels per acre; rye, of which considerable is grown, from 15 to 25 bushels; hay, from 1 ton to 1½ tons per acre. Some wheat and barley are also grown, but the acreage is small and yields are low. Corn does not do well on account of the droughty condition of the soil, except during wet years, when fair yields of fodder are secured. Considerable difficulty is experienced in securing a stand of clover, and as a result timothy is the principal hay crop. Some peas and potatoes are grown as special crops, but the yields are low. The most common rotation followed consists of corn or peas, oats, rye, and hay. The sod is usually manured before being plowed again. No commercial fertilizers are used. The gravel and cobblestones interfere somewhat with cultivation, but fair tilth can be obtained with but little difficulty.

The system of farming followed should include the incorporation of organic matter, which may be accomplished by supplementing the

stable manure with green manuring crops such as clover, vetch, or soy beans. The acidity of the soil may be corrected by applying ground limestone at the rate of 1,200 pounds per acre. The methods of improvement suggested for the Rodman sandy loam also apply to this type. The type is well located in regard to shipping facilities and the trucking industry might be profitably developed.

FOX SAND.

The surface soil of the Fox sand consists of a light-brown medium sand, loose and open in structure, and extending to an average depth of 6 inches. It contains only a small amount of organic matter, except in the valley of the Kewaunee River, where the water table is near the surface and the soil is springy and darker in color than in other places. The subsoil is an orange or reddish-brown, loose, incoherent medium sand, which extends to a depth of about 12 feet, where red clay is usually encountered. A sprinkling of gravel is common on the surface, and gravel beds may be encountered at 3 feet. The subsoil shows stratification in places.

The Fox sand is of limited extent, occupying an area of about 3 square miles. Its largest development is in southwestern Casco and southeastern Luxemburg Townships. A few small areas occur in West Kewaunee and Carlton Townships.

The surface of the type is flat to gently undulating. South of the railroad in sections 30 and 31, Casco Township, there is a pronounced terrace from 50 to 60 feet high running parallel with the river. The type is more undulating in the valley than on the higher land. The natural drainage is excessive, except in the valley of the Kewaunee River, where a few small tracts are springy.

This type consists of glacial material which has been reworked by glacial streams and deposited as overwash plains or as terraces. The surface of the material is in an acid condition.

The original timber growth consisted chiefly of white pine, and it is reported that the type supported the best growth of pine to be found in the county.

All of the type is cleared except a strip along the Kewaunee River. Rye and oats are the leading crops, but yields are small. From 5 to 15 bushels of rye and 15 to 20 bushels of oats are produced per acre. Timothy seldom yields over 1 ton per acre, and it is very difficult to get a stand of clover. Peas are also grown, but the yields are not such as to make the crop profitable. The system of cropping followed usually consists of corn or peas, oats, rye, and hay. Pasturage on this soil is poor because of insufficient moisture, except in the early spring and summer. Corn is grown principally for fodder and the yield is low.

The system of farming on this soil should be such as to increase its organic matter content and water-holding capacity. Stable manure should be supplemented by green manuring crops, the soil should be limed, and the use of commercial fertilizers as suggested for the Rodman sandy loam may be found advisable. This type is better adapted to the production of early truck crops than to general farming, and as most of the type is located along the railroad it would seem that this industry could be developed.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Fox sand:

Mechanical analyses of Fox sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311619.....	Soil.....	2.0	13.5	22.2	40.3	8.2	9.2	4.6
311620.....	Subsoil.....	.9	9.3	18.2	55.8	5.0	5.7	5.2

POYGAN SILT LOAM.

The surface soil of the Poygan silt loam to an average depth of 10 inches consists of a black silt loam to silty clay loam, and contains a large amount of organic matter. The subsoil is a red, heavy silty clay, identical with the subsoil of the Kewaunee clay loam. The material is stiff and tenacious, but contains considerable finely ground limestone and is quite calcareous. In the areas back from the shore of Green Bay the upper subsoil consists of a yellowish-brown clay loam and the red clay loam is not encountered until a depth of from 16 to 18 inches is reached.

This type is very limited in extent and of comparatively little importance, yet it constitutes a distinct type. It is found as a narrow strip bordering the shore of Green Bay and in a few small areas in Red River Township.

The surface of the type is level, and on account of the heavy nature of the soil and subsoil, the natural drainage is poor. Practically all of the type should be tile drained.

The material composing the soil is largely of lacustrine origin, probably influenced somewhat by glacial action since the first deposition. On account of its low position and poor drainage, there has been a growth and decay of vegetation in the presence of moisture, which accounts for its high organic matter content and dark color. The surface soil frequently shows slight acidity, but the subsoil is calcareous.

The original timber growth consisted chiefly of elm, ash, cedar, and hemlock, with a few other varieties. The timber has all been removed.

The soil is naturally strong and productive, and practically all of it has been cleared and cultivated. The lack of drainage, however, is the limiting factor, and in wet seasons crops are frequently lost entirely. Oats yield 30 to 35 bushels, wheat 12 to 15 bushels, and hay, consisting chiefly of timothy, about 2 tons per acre. Corn does fairly well and gives good yields of fodder. On drying, the soil cracks and cultivation must be confined to a rather narrow range of moisture conditions or difficulty will be experienced in securing good tilth. If worked when moisture conditions are most favorable, a good seed bed can be obtained.

Drainage is the most important factor in the improvement of this soil and tile drains should be installed over all of the type. When properly drained the yields will be materially increased and the returns will be large. The soil is well adapted to corn, hay, and grasses, and when properly drained and cultivated should become one of the most productive types in the county.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Poygan silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311605.....	Soil.....	0.0	1.7	3.8	11.4	11.8	53.6	17.3
311606.....	Subsoil.....	.6	2.5	4.2	12.7	9.5	38.7	31.5

The following sample contained more than one-half of 1 per cent calcium carbonate (CaCO_3): No. 311606, 8.45 per cent.

POYGAN SAND.

The surface soil of the Poygan sand consists of 10 inches of dark-brown or black medium sand or light sandy loam. It is rich in organic matter and quite loose and mellow under cultivation. The subsoil is a grayish or yellowish sand, extending to a depth of 2 to 3 feet, where red clay is encountered.

The type is of very limited extent, occupying less than one-half square mile, and is confined to a narrow strip along the shore of Green Bay, in the northwestern corner of the county.

The surface is level to undulating, and on account of its sandy nature the drainage is good. The soil does not suffer materially during dry weather, as the water table is comparatively near the surface and the clay assists in retaining moisture.

The red clay underlying the type is of lacustrine origin. The sandy material is largely of glacial origin, but has doubtless been acted upon by the waters of Green Bay when at a higher level than at present, since the type occurs chiefly as a bench along the shore of the bay. The sand may represent in part a beach formation upon which there has been a growth and decay of vegetation in the presence of moisture, giving rise to the organic-matter content and the dark color of the soil. The surface soil is acid, but the red clay subsoil is of a calcareous nature.

The original timber consisted chiefly of a little hardwood, including maple and ash, with some hemlock and a few other varieties.

Most of the type is cleared, and the chief crops are oats, corn, and potatoes. Much of it is used for pasture.

The acid condition should be corrected by the application of ground limestone. It is thought that cabbage and onions could be successfully grown upon this soil, in addition to the ordinary farm crops.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of the Poygan sand:

Mechanical analyses of Poygan sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311607.....	Soil.....	0.5	7.1	45.8	29.6	2.3	10.7	3.4
311608.....	Subsoil.....	.7	5.8	35.0	33.2	5.3	10.3	9.8

The following sample contained more than one-half of 1 per cent calcium carbonate (CaCO_3): No. 311608, 11.09 per cent.

GENESEE LOAM.

The surface soil of the Genesee loam consists of a brown, heavy loam or light clay loam, extending to a depth of 10 inches. The subsoil is a brown or reddish-brown silty clay loam, somewhat lighter in color than the soil, and quite compact and impervious. In some localities it approaches in character the Kewaunee clay loam. In places some gritty material is mixed with the subsoil, and a few stones are occasionally found on the surface. Immediately along the stream the surface is darker than at the foot of the bluffs.

This type is of limited extent and of minor importance. It occurs chiefly in the bottoms along the Kewaunee River and its tributaries and also along some of the smaller streams in the area.

The surface of the type is nearly level, with only a gentle slope from the foot of the bluffs down to the stream. The type occupies the first bottoms and is subject to overflow. On account of its low position and heavy character the natural drainage is poor.

The material composing the type is of alluvial origin and derived from the wash from glacial and lacustrine soils of the upland.

The original timber growth consisted chiefly of elm, ash, cedar, a few pines, and hemlock. A portion of the type is still in timber.

Only the better drained areas bordering the upland are under cultivation. The remainder is in pasture and good grazing is furnished throughout the entire season. Where farmed, oats, barley, rye, corn, and hay are grown with success, although over all of the bottoms there is danger of overflow and damage to the crops during seasons of the heaviest rains.

Where the danger from overflow is not too great tile drains could be installed to advantage and the cultivated area profitably extended. All of the general farm crops common to the region could then be grown to a greater extent. Care should be used in plowing and the land should be tilled only when the moisture conditions are most favorable.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Genesee loam:

Mechanical analyses of Genesee loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311617.....	Soil.....	0.7	4.6	7.7	21.3	13.3	35.4	16.7
311618.....	Subsoil.....	.2	1.8	3.7	11.9	10.9	43.8	26.8

GENESEE FINE SANDY LOAM.

The surface soil of the Genesee fine sandy loam consists of a brown or dark-brown loam, extending to an average depth of 10 inches. The type as a whole contains considerable fine sand, and spots of sand too small to map are frequently found. A scattering of gravel may occur upon the surface and boulders are plentiful over limited areas. The subsoil consists of a loam or clay loam, lighter in color than the soil and extending to a depth of from 12 to 21 inches, where gravel and sand are usually encountered. The underlying limestone is frequently within reach of the auger and outcrops are quite numerous. In section 14, West Kewaunee Township, on the north side of the river, there are only a few inches of soil over the rock in places, and over several areas the limestone is entirely bare. On the south side of the river the soil is from 2 to 3 feet deep over the rock. Over small areas the surface is strewn with boulders to such an extent as to interfere with cultivation.

The type is inextensive and of little importance. It is confined to the bottom lands along the valley of the Kewaunee River and its tributaries.

The surface is nearly level, with usually a gentle slope from the foot of the higher land down to the stream banks. Owing to the medium and coarse material in the subsoil and the loamy nature of the surface, the natural drainage of the type is fairly good. Where the gravel lies near the surface the type suffers somewhat from drought during late summer. A great part of the type is subject to overflow and some damage to crops results from this source. After the water recedes, however, the land drains quite rapidly. Some of the lowest areas would be benefited by tile drains.

The Genesee fine sandy loam is of alluvial origin and the material composing the soil has been washed from the glacial and lacustrine deposits of the surrounding upland region. The surface material shows slight acidity.

The original timber growth consisted chiefly of elm, ash, hemlock, pine, and cedar. Over areas in which the rock closely approaches the surface and in some other places the timber is still standing.

Excepting the stony and rocky areas, most of the type is cleared and cultivated. All of the crops common to the region are grown and yields are good. Clover does better than on most of the upland types. Potatoes yield from 100 to 125 bushels per acre. The portion of the type not cultivated is pastured.

The lowest, most poorly drained parts of the type should be tile drained. Definite crop rotations should be worked out and carefully followed. The methods of cultivation should be thorough, so as to hasten the maturing of the crops as much as possible, since high water may frequently delay planting in the spring.

The following table gives the results of a mechanical analysis of a sample of soil of the Genesee fine sandy loam:

Mechanical analysis of Genesee fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311615.....	Soil.....	4.0	8.4	10.2	19.7	8.0	34.7	14.7

DUNKIRK SAND.

The surface soil of the Dunkirk sand consists of a light to dark-brown sand or loamy sand of medium texture, extending to an average depth of 6 inches. The upper subsoil frequently has a rusty appearance, and at about 2 feet this grades into a yellowish medium

sand. The amount of organic matter in the soil is somewhat variable, being low over most of the type, but increasing considerably close to the foot of the bluffs on the lower bench and giving the soil a dark color. Red clay is encountered at 6 to 10 feet below the surface.

The Dunkirk sand is limited in extent, comprising less than 2 square miles. It is confined to a narrow strip bordering Lake Michigan and extending from the northeast corner of the county to several miles below Algoma. It is not continuous, however, for the entire distance.

The type occurs as two distinct benches or terraces along the Lake. The surface of these terraces is level to undulating. The natural drainage is good, except at the foot of the bluffs, especially in the lower bench, where the seepage from the higher land keeps the soil wet and springy.

The terraces were formed when Lake Michigan was at higher levels than at present, and the sand probably represents beach formations. The lower bench is from 4 to 6 feet and the higher nearly 40 feet above the level of the Lake. The red clay which occurs beneath the deposits of sand is of lacustrine origin.

The original timber growth included scrubby oak, with some other hardwoods and a mixture of pine, hemlock, and cedar.

The lower bench is much more limited in extent than the upper, is rather poorly drained in places, and is devoted chiefly to pasture. The upper bench is largely cultivated, and most of the crops common to the region are grown. Oats, rye, and timothy are the chief general farm crops, and of the special crops peas, beans, and potatoes are most extensively grown. The average yields are lower than on the heavier soils, but compare favorably with the returns received from the other sand types of the county.

The type is low in organic matter over most of its extent, and this should be supplied by supplementing stable manure with green manuring crops. The soil is better adapted to truck crops than to general farming, and the trucking industry should be more highly developed. The surface soil is acid, which condition may be corrected by applying ground limestone at the rate of about 1,200 pounds per acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Dunkirk sand:

Mechanical analyses of Dunkirk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311601.....	Soil.....	2.9	9.0	24.1	49.7	1.9	6.9	5.7
311602.....	Subsoil.....	.6	4.7	23.1	65.6	1.6	1.6	2.7

CLYDE SILT LOAM.

The surface soil of the Clyde silt loam consists of a dark-gray to black silt loam, extending to an average depth of 12 inches and containing a very large amount of organic matter. The subsoil consists of a drab or bluish silty clay or clay loam, which contains considerable limestone material in the form of grit and gravel. Iron concretions are also present in places. The type as found in different parts of the county shows considerable variation. In the marsh areas in the southeastern part of Lincoln Township the surface consists of about 4 to 8 inches of well-decomposed peat, underlain by a black silt loam to 12 inches, where a drab-colored clay is encountered. This clay has a pinkish tinge at 2 to 3 feet. Clay resembling that of the Kewaunee clay loam is frequently found in the deep subsoil. In section 33, Montpelier Township, the soil is very heavy and somewhat similar to Clyde clay loam. In some places the type is underlain by white sand, but the variations are not of sufficient extent or importance to be separated on the soil map.

The Clyde silt loam occupies low, swampy depressions varying in size from a few acres to over a square mile in extent. The areas are found in all parts of the county.

The surface of the type is level, and owing to its low position and heavy subsoil it is very poorly drained.

The type occupies marshy depressions, some of which may be old lake beds. The material consists of glacial and lacustrine debris, with which there has accumulated a large amount of vegetable matter in the presence of moisture, resulting in the high organic matter content and the characteristic dark color. While the subsoil is calcareous, the surface may be acid in a few places.

The original timber growth was chiefly black ash, elm, and cedar, with a very few maples, willows, etc. Most of the type is still in timber.

Only a small part of the type has been cleared, and most of this is used for pasture land.

The main question in the improvement of this type is that of drainage. Most of the Clyde silt loam could be drained, and when once reclaimed it would be a very strong and valuable soil. Where subject to overflow from streams drainage would be difficult unless the area were of sufficient size to warrant deepening the stream. Where the rock is near the surface, as in the area near Thiry Daems, drainage would be impracticable. Areas of this soil reclaimed in other regions produce good yields of corn, cabbage, sugar beets, hay, and a variety of other crops.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Clyde silt loam.

Number.	Description.	Fine gravel.	Coars ^s sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311603.....	Soil.....	0.2	9.1	4.4	10.0	5.0	52.4	18.2
311604.....	Subsoil.....	.3	1.5	1.7	6.2	6.9	71.0	12.2

PEAT.

The material included in this type consists of vegetable matter in varying stages of decomposition, with which there is sometimes incorporated a small amount of mineral matter. The color is dark brown to black, and the material extends to a depth of from 8 inches to considerably more than 6 feet. Probably the larger part of the Peat is thoroughly decomposed and of a black color, though some of it is still in a fibrous condition. The underlying material consists chiefly of clay, though sand was found under some of the marshes. The beds of sand are not continuous, however, and appear to be of comparatively small extent.

The three largest areas of Peat, occupying about 3 square miles each, are found in the eastern part of Lincoln, the northeastern part of Red River, and the northwestern part of West Kewaunee Townships. Areas of about a square mile each occur at the mouth of the Kewaunee River and in the northwestern part of Franklin Township. Numerous smaller patches are found in all the townships of the county.

The areas of Peat are all level and the drainage is very poor.

The original timber growth on this type consisted of tamarack and black ash, with some elm, cedar, soft maple, and willow. Where the Peat is deepest the tamaracks are the chief growth, while around the borders of the marshes or where the Peat is shallow black ash is the predominating tree growth. A few of the swamps are timbered chiefly with white cedar. Much of the timber is still standing, though nearly all of the cedar suitable for posts has been cut. On the marsh at Kewaunee the growth consists only of wild grasses.

The areas of Peat in Kewaunee County have not been reclaimed, and it is evident that comparatively little thought has been given to the drainage of the larger marshes.

The first and most important problem in the improvement of the Peat type is the question of drainage. It is thought that practically all of the marshes in the county, except at the mouth of Kewaunee

River, could be drained and profitably cultivated. The marsh in West Kewaunee has considerable sand underneath it, and for this reason some portions of it might not be as productive or lasting as the other large marshes where clay is the underlying material. The marsh at Kewaunee is but little above the level of the lake and could not be reclaimed without a very expensive system of diking. It is too soft at present to permit the cutting of the marsh hay. Before drainage projects are undertaken on any of the larger marshes accurate levels should be taken to determine exactly the fall available and the opinion of experts secured as to the best methods to be followed in laying out and constructing the drains. When reclaimed the Peat will be adapted to a variety of crops, including most of the general farm crops now grown on the uplands. It is rich in nitrogen, but would doubtless require the application of mineral fertilizers in order to keep up its productivity.

SUMMARY.

Kewaunee County is located on Lake Michigan in the eastern part of the State and comprises an area of 341 square miles or 218,240 acres.

The surface of the area varies from level to rough and the most pronounced feature is the Kettle Moraine, which begins near the center of Casco Township and extends southward. The bluffs along the lake range from 50 to 100 feet in elevation and the highest points in the county are over 150 feet above the lake level. With the exception of a small area in the northeastern part of the county, the drainage is into Lake Michigan, chiefly through the Kewaunee River and its tributaries.

The county was organized in 1856 and agricultural development began about that time. Kewaunee and Algoma are the chief towns. The area is traversed by the Kewaunee, Green Bay & Western Railroad and a branch line called the Ahnapee & Western.

The average rainfall for this region is about 30 inches and the mean annual temperature 43° F. There is an average growing season of from about 145 to 150 days free from killing frost. The winters are long and severe and the summers cool and pleasant. The summer nights are usually cool, which retards the rapid growth of corn and makes it more difficult to mature than in some sections where the growing season is shorter but the nights warmer.

The type of agriculture followed at present consists of general farming, with dairying as the most extensively developed branch. There are 63 cheese factories and 10 creameries in the county and the output from these is gradually increasing. The dairy stock is mostly

of mixed breeding, but is being improved by the use of pure-bred sires. The general farm crops grown consist of oats, barley, rye, hay, wheat, and corn, with smaller acreages of potatoes, sugar beets, peas, and a little flax. The growing of fruit and truck crops has not developed to any extent. The most common rotation followed consists of corn or peas, followed by oats, barley, rye, or wheat for one or two years. Clover and timothy are seeded with the grain, and hay is cut for one or two years. The fields may be pastured for a season. Fall plowing is quite common, especially on the heavy soils which are likely to be wet and backward in the spring. The Kewaunee clay loam is the most difficult to cultivate of the various types in the county. Many parts of the county are in need of tile drainage, and this is one of the most serious problems in the region. The most noxious weeds are quack grass and Canada thistle, and many farms are badly infested with these pests.

There are 21 soil types in Kewaunee County, although a number of these are of small extent and of little importance.

The Kewaunee clay loam is the most important and by far the most extensive type. It occurs as a belt along the lake shore and is also extensively developed in the western part of the county. It is a strong soil and rather difficult to work but productive when properly handled. Much of it is in need of tile drainage. By far the greater part of the type is under cultivation to small grains. Peas constitute the chief special crop.

The Kewaunee loam is an important type in the northern part of the county, where it is closely associated with the Kewaunee clay loam. It is a good soil, and most of it is cultivated. General farming and dairying are the main agricultural pursuits, oats forming the principal special crop.

The Kewaunee fine sandy loam is of small extent, but most of the type is under cultivation and devoted to general farming. It is better adapted, however, to truck and small fruits.

The Superior clay loam, till phase, is confined to Carlton and West Kewaunee Townships. It closely resembles the Kewaunee clay loam, with which it is associated. It is a strong soil for general farming and dairying but needs artificial drainage.

The Miami loam is a widely developed type in the county and constitutes a fair general farming soil. The dairying industry should be extended over this type.

The Rodman gravelly loam resembles the Miami loam, except that it contains a large quantity of gravel, is underlain by stratified material, and frequently has boulders upon the surface. It is not an extensive type and occurs in widely distributed areas. But little of the type is cultivated, and where timbered it should be kept in forest.

The Rodman gravelly sandy loam is of small extent. Very little of this soil has ever been cultivated and crop yields are low. Most of the type is nonagricultural, and in general it is best suited to grazing and forestry.

The Rodman gravel has practically no agricultural value and occupies only a few small areas. It would be useless to attempt its cultivation, and it should be kept in timber.

The Rodman sandy loam is not widely developed, but covers a larger area than the gravel or gravelly loam types. It is easy to cultivate and responds readily to fertilization and careful treatment. Most of the type is cultivated and fair yields are secured. The methods of farming should be improved.

The Rodman fine sand is of small extent and little importance. It could be improved by the addition of organic matter. The type is better suited to early truck crops than to general farming.

The Fox silt loam is a good general farming soil, and practically all of the type is under cultivation. The corn crop should receive greater attention, and alfalfa should be more extensively grown. Dairying constitutes the most promising industry. The type is somewhat deficient in organic matter.

The Fox sandy loam, gravelly sandy loam, and sand types are all of limited extent, but nearly all of the soils are cultivated. They are devoted to general farming and fair yields are secured.

The Poygan silt loam is a strong soil, yet this soil and the Poygan sand are so inextensive as to be of little agricultural importance.

The Genesee loam and fine sandy loam types comprise a small total area and occupy the bottom lands along the chief streams of the county. The former type affords good pasturage and little of it is cultivated, while the greater part of the latter is cultivated, good yields of the crops common to the region being secured.

The Clyde silt loam is fairly extensive and occupies low-lying areas where there has been an accumulation of vegetable matter, but not in sufficient quantities to form Muck or Peat. A small part of the type has been cleared and is used for pasture. It is naturally a rich soil, but needs drainage. If reclaimed, this would become a strong and valuable soil.

None of the Peat lands of Kewaunee County have been reclaimed, although they are comparatively extensive, and by careful drainage and proper cultivation could be made to produce profitable crops.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following.

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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